

The 1,85 Ga old Sudbury Igneous Complex (SIC) in the central part of the Sudbury multi-ring impact structure (Ontario, Canada), together with the clast-rich impact melt breccia, the Sublayer, are interpreted as the product of an in-situ differentiation of a homogeneous impact melt [1]. New geochemical data for major, minor and trace elements, including the Rare Earth Elements (REE's), isotope characteristics as well as U-Pb systematics of zircon and baddeleyite strongly support this interpretation. Moreover, the data indicate that the Offset Dikes were formed in a late stage of cratering when differentiation has already begun.

For this study, surface rock samples as well as material from the drillcore 70011 (Wisner Township, North Range; INCO Ltd.) were analyzed with geochemical and isotope-geochemical methods. The continuously sampled drillcore allowed for the first time to evaluate changes in elemental concentrations from bottom (norite) to top (granophyre) of the SIC, unbiased by sampling strategies. Almost all elements show smooth changes over the whole, more than 2.5 km thick SIC. This behavior is typical for differentiation of a silicate melt with one homogeneous starting composition. A comparison of the distribution of selected elements from drillcore 70011 with data for the Skaergaard Intrusion is given in Fig. 1. Concentration profiles for the SIC and the Skaergaard Intrusion follow the same trends yet the concentration maxima for the SIC are displaced to lower relative heights. We attribute this shift to the higher SiO_2 content of the undifferentiated impact melt pool at Sudbury (64 wt.-%, [2]) compared to the Skaergaard magma (48 wt.-%, [3]). Fig. 2 illustrates the variation of the $\text{Fe}_2\text{O}_3/\text{MgO}$ ratio in the SIC. The maximum $\text{Fe}_2\text{O}_3/\text{MgO}$ ratio is found in the lower third of the granophyre; whereas, the lowest values occur on top and bottom of the schematic stratigraphic column indicating progression of the cooling from both interfaces of the impact melt layer with cooler material (*i.e.*, crater floor breccias, and suevites of the Onaping Formation). This cooling was accompanied by differentiation of the melt. Typical features for a gravitational differentiation, *e.g.*, cumulate layers, are missing in the case of the SIC. We, therefore, suggest in-situ differentiation (as proposed by [4]) as mechanism for the chemical evolution of the melt. The seemingly abrupt enrichments in TiO_2 , P_2O_5 , V, Sc and Zr, as well as the decrease in SiO_2 in the quartz-gabbro, simply reflect the fall below of a thermal boundary with the onset of Fe-Ti-oxide, apatite, and sphene crystallization. The quartz-gabbro corresponds to Fe-Ti-oxide-apatite-rich transition zones at other „layered intrusions“. The hypothesis that the felsic (granophyre) and the mafic (quartz-gabbro, norite) units of the SIC have been produced in different processes (impact melting of crustal material, and partial melting of the Upper Mantle), can be rejected on the basis of our geochemical results. For accessory minerals of the Foy Offset Dike a crystallization age of $1852 \pm 4/-3$ Ma (2σ) has been determined [5]. Total absence of inherited zircons, isotope geochemistry as well as the results of the geochemical investigations point to the noritic character of the melt now forming the Foy Offset Dike and to the fact that the Foy Offset Dike clearly belongs to the melt system of the SIC. The forming of the Foy Offset Dike occurred not exactly coevally but short after the emplacement of the SIC, because of the noritic character of the Foy Offset Dike material. Numerical mathematical calculations for the cooling history of the SIC estimate that the time span between emplacement and temperature decrease below the solidus point is about 0,25 Ma [6]. In consequence, the emplacement of the Foy Offset Dike took place during this period.

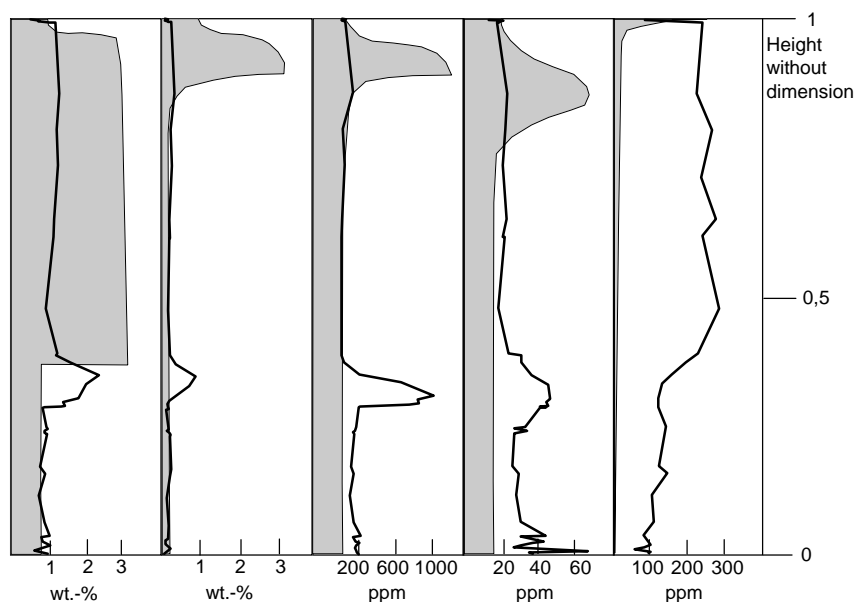


Fig. 1
Simplified profiles for selected major- and minor element concentrations in the drillcore 70011 (lines) compared to the same concentrations in the Skaergaard Intrusion (in gray, modified after [3]). Both profiles show the same trends, but the SIC profiles are shifted to lower heights. The initial SiO_2 -content of the Skaergaard Intrusion is 48 wt.-% [3], whereas the SiO_2 -content of the SIC is about 64 wt.-% [2].

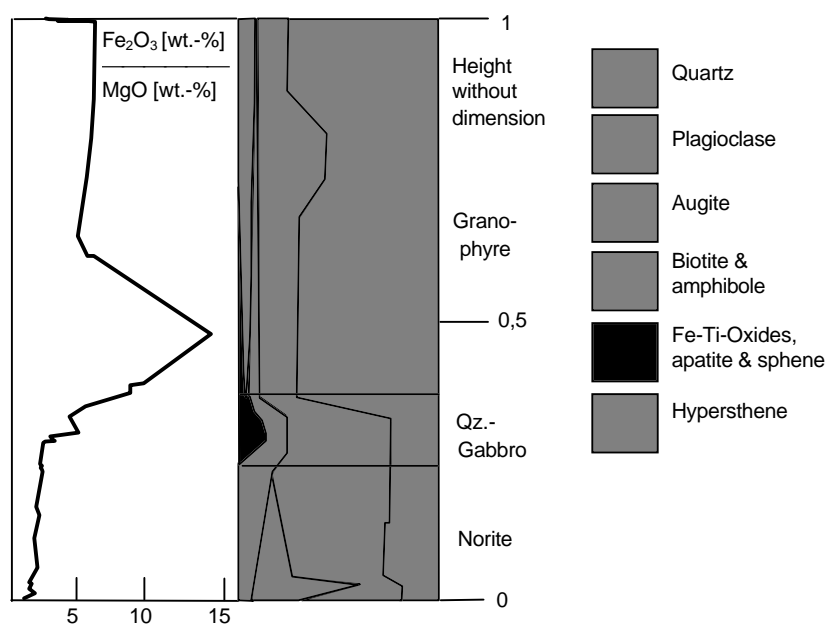


Fig. 2
 $\text{Fe}_2\text{O}_3/\text{MgO}$ -ratio in the sampled profile of the drillcore 70011 compared to the mineralogical composition of the Main Mass in the North Range of the SIC (modified after [7]). The maximum in the $\text{Fe}_2\text{O}_3/\text{MgO}$ -ratio is not correlated to a lithological border. The cooling of the SIC occurred from the top and the bottom of one silicate melt layer.

References. [1] e.g., Deutsch, A. et al. (1995) *Geol. Rundschau*, 84, 697-709; Deutsch, A. (1994) *Geol. Soc. Am. Spec. Pap.*, 293, 289-302; [2] Collins, W. H. (1934) *Trans. Royal Soc. Can.*, 28 (Sect 4), 123-177; [3] Wager, L. R. and Brown, G. M. (1968) *Oliver & Boyd, Edinburg & London*, 588 S.; [4] Tait, S. and Jaupart, C. (1996) *Mineral. Mag.*, 60, 99-114; [5] Ostermann, M. et al. (1996) *Meteoritics & Planet. Sci.*, 31, 494-501; [6] Ivanov, B. et al. (1997) *this volume*; [7] Naldrett, A. J. et al. (1970) *Econ. Geol.*, 65, 122-155.